भारतीय मानक

Indian Standard

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विद्युत कर्षण मोटर — प्रदर्शन और कार्यात्मक आवश्यकताएं

Electric Traction Motor — Performance and Functional Requirements

ICS 43.120

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Electric and Hybrid Vehicles Sectional Committee, TED 27

FOREWORD

This draft Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Electric and Hybrid Vehicles Sectional Committee and approved by the Transport Engineering Division Council.

Traditionally road vehicles (cars, buses and trucks) have used diesel and petrol engines with a mechanical or hydraulic transmission system. In the latter part of the 20th century, vehicles with electrical powertrain began to be developed.

A traction motor is an electric motor used for propulsion of an electric roadway vehicle.

Traction motors are used in electrically powered rail vehicles (electric multiple units) and other electric vehicles including electric milk floats, elevators, roller coasters, conveyors, and trolleybuses, as well as vehicles with electrical transmission systems (diesel-electric, electric hybrid vehicles), and battery electric vehicles. Advantage of using electric machines is that specific types can regenerate energy (that is, act as a regenerative brake)-providing deceleration as well as increasing overall efficiency by charging the battery pack.

In the formulation of this standard assistance has been taken from following standards:

IS/IEC/UL	*Title*
IS 9000 (Part 7/Sec 6) : 1988	Basic environmental testing procedures for electronic and electrical items: Part 7 Impact test, Section 6 Test Ee: Bounce
IS 9000 (Part 8) : 1981	Basic environmental testing procedures for electronic and electrical items — Part 8: Vibration (sinusoidal) test
IS 12065 : 1987	Permissible limits of noise level for rotating electrical machines
IS 12075 : 2008	Mechanical Vibration of Rotating Electrical Machines with Shaft Heights 56 mm and higher – Measurement, evaluation and limits of vibration severity
IEC 60034-14 : 2018	Rotating electrical machines — Part 14: Mechanical vibration of certain machines with shaft heights 56 mm and higher — Measurement, evaluation and limits of vibration severity
UL 1004-1	Standard for Safety: Rotating electrical machines — General requirements

The committee composition responsible for the preparation of this standard is given in Annex A.

For the purpose of deciding, whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

ELECTRIC TRACTION MOTOR — PERFORMANCE AND FUNCTIONAL REQUIREMENTS

1 SCOPE

These standard covers performance and tests related to safety, performance, environmental suitability, electromagnetic compatibility (EMC) and durability of traction motors with controllers used in motor vehicles having pure electric propulsion modes.

The standard covers all types of traction motors with controllers to be used in vehicles with pure electric propulsion modes

In case of traction motors integrated with an electric drive transmission enclosure (that is, gearbox, drive axles, etc), the validation for such electric drive transmission can be agreed between motor/vehicle manufacturers and the test agencies

2 REFERENCES

The standards given below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of these standards.

IS/IEC/AIS No	*Title*
IS 17191 (Part 1) : 2019	Electric Power Train Vehicles: Measurement of electrical energy consumption
(Part 3) : 2019	Measurement of net power and the maximum 30 minute power
IS 1231 : 2019	Dimensions and Output Series of foot mounted induction motors — Frame numbers 56 to 315 L
IS 1271 : 2012/IEC 60085 : 2007	Electrical insulation — Thermal evaluation and designation
IS 2223 : 1983	Dimensions of flange mounted ac induction motors
IS 4029 : 2010	Guide for testing three phase induction motors
IS 6362 : 1995/IEC 60034-6 : 1991	Designation of methods of cooling of rotating electrical machines
IS 9000 (Part 5/Sec 1) : 1981	Basic environmental testing procedures for electronic and electrical items: Part 5, Section 1 Damp heat (cyclic) test
IS 9000 (Part 11) : 1983	Basic environmental testing procedures for electronic and electrical items: Part 11 Salt mist test
IS 15999 (Part 1) : 2021/IEC 60034-1:2017	Rotating electrical machines: Part 1 — Rating and performance
IEC 60034-30-1 : 2014	Rotating electrical machines — Part 30-1: Efficiency classes of line operated AC motors (IE code)
IEC 60034-30-2 : 2016	Rotating electrical machines — Part 30-2: Efficiency classes of variable speed AC motors (IE code)
IEC 60349-1 : 2010	Electric traction — Rotating electrical machines for rail and road vehicles Part 1: Machines other that electronic converter fed alternating current motors
IEC 60349-2 : 2010	Electric traction — Rotating electrical machines for rail and road vehicles — Part 2: Electronic converter fed alternating current motors.
IEC TS 60349-3 : 2010	Electric traction — Rotating electrical machines for rail and road vehicles — Part 3: Determination of the total losses of converter-fed alternating current motors by summation of the component losses”

IS/IEC/AIS No	*Title*
AIS 004 (Part 3) : 2009	Automotive Vehicles — Requirements for electromagnetic compatibility

3 DEFINITIONS

For the purpose of this standard definitions given in IS 17191 (Part 1), IS 15999 (Part 1) and IEC 60349 shall apply.

4 SUPPLY CONDITIONS

4.1 Voltage

The nominal voltage intended to be supplied to the motor shall be specified. The voltage shall be based on the speed and torque range required by the vehicle manufacturer. RPM may be declared over the entire range of operation.

4.2 Ambient Temperature:

The motor shall be rated for ambient temperature of 25 ± 5 °C. All performance test shall be conducted at 40^{+5}_{0} °C.

5 CONSTRUCTIONAL REQUIREMENTS

5.1 Dust and Water Ingress

5.1.1 ‘Closed circuit’ motors as defined in IS 6362, shall have an Ingress Protection of IP57 or higher.

5.1.2 ‘Open circuit’ motors as defined in IS 6362, shall comply with insulation resistance test as per 5 of IS 4029 before and after immersion of motor in water for 30 min at 1 meter depth. Motors complying to the condition where the maximum voltage of a galvanically connected electrical circuit between a DC live part and any other live part (DC or AC) is ≤ 30 V AC (rms) and ≤ 60 V, shall be exempted from this requirement.

5.2 Mounting

The construction and mounting shall be foot mounted (B3) or Flange mounted (B5). Frame sizes and mounting dimensions may be as specified in IS 1231 or IS 2223. Other non-standard mounting dimensions may be as agreed between motor manufacturer and vehicle manufacturer as per specific requirement.

5.3 Vibration and Shocks

Motors shall be suitable to withstand the normal shocks and vibrations subjected to during normal operation. This shall be ensured as per tests at **8.1** and **8.2.**

5.4 Cooling and Ventilation

The cooling and ventilation methods for motor shall be as per IS 6362.

5.5 Corrosion Protection

The corrosion protection system (painting scheme and process) should protect the motor from corrosion due to water, salt and contaminants like grease, oil etc. This shall be ensured as per tests at **8.4** and **8.5.**

6 ELECTRICAL INSULATION

The insulation system shall be of thermal Class F minimum as per IS 1271.The insulation system (materials and processes) shall be designed by the manufacturer to take care of the voltage spikes and high rate of change of voltage rates caused by the variable frequency drive or controller giving supply to the motor.

7 PERFORMANCE TEST

7.1 Temperature Rise Under Rated Load

The temperature of the motor under rated full load condition (nominal speed and torque) while being supplied with the rated voltage and frequency as per IS 15999 (Part 1). The temperature rise during maximum 30 minute power as per IS 17191 (Part 3), shall be below the limit specified for thermal class of the insulation (that is, 155 °C for Class F, 180 °C for Class H).

The motor/vehicle and its entire equipment assembly shall be conditioned for minimum four hours at a temperature of 25 ±5 °C before the test. The electric motor/vehicle shall be run on the bench dynamometer/chassis dynamometer at a power, which is declared by manufacturer for the maximum 30 minute power.

The speed is recommended to be in a range, at which the net power is greater than 90% of the maximum power [*see* IS 17191 (Part 3)]. This speed shall be declared by the manufacturer.

7.2 Temperature Rise under Short Time Over Load or Net Power

This test shall be carried out after the rated full load temperature rise test. The motor is allowed to cool down by 55 °C (Class F) and 60 °C (Class H, Class 200, Class 220 and Class 250) before commencing the short time overload.

The net power test shall consist of a run at full setting of the power controller.

Just before beginning the test, the vehicle/motor shall be run on the chassis/bench dynamometer for three minutes delivering a power equal to 80 percent of the rated maximum power at the speed declared by the manufacturer.

The whole test shall be completed within 5 minutes. The batteries can be recharged to complete the power curve measurement.

Final temperature of the motor after short time overload condition shall be below the limit specified for thermal class of the insulation (that is, 155 °C for Class F, 180 °C for Class H, 200 °C for class 200, 220 °C for Class 220 and 250 °C for Class 250).

7.3 Continuous Full Load Efficiency

The motor shall have a full load efficiency of IE2 level or higher as per IEC 60034-30-1 or IEC 60034-30-2 as applicable.

7.4 Torque Speed Characteristics

The motor shall be capable of delivering the torque at various speeds as specified by the motor manufacturer. It shall be tested in accordance with IS 15999 (Part 1).

7.5 Over-Speed

The motor shall be able to withstand an over-speed of 1.2 times the maximum rated speed.

8 TYPE TESTS/VALIDATION TESTS

These are intended to prove the general qualities and design of the given type of electric traction motor, to check constructional and structural integrity as well as suitability for the purpose. The tests are carried out to prove conformity with the requirement.

8.1 Sinusoidal Vibration Withstand Test

The traction motor shall be subjected to this test. The test shall be carried out at room temperature not exceeding 30 °C.

8.1.1 *Test Description*

The motor shall be firmly held on the vibration table with a suitable fixture. The traction motor shall be subjected to a vibration level of 3g and a frequency of 30-150 Hz at a sweep rate of 1 octave per minute. The test shall be carried out for 2 h in each axis (X, Y and Z plane).

8.1.2 *Requirements*

After the test no cracks shall be visible on the traction motor and the motor shall be functional when tested at rated voltage and current.

8.2 Shock or Impact Test

8.2.1 *Test Description*

The traction motor shall be subjected to this test in vehicle mounted condition. The test shall be carried out at room temperature not exceeding 30 °C. Shock test shall be carried out in all three axes viz. in the vertical axis, longitudinal and horizontal axis.

The motor shall be held firmly on the shock table as recommended by the manufacturer and shall be subjected to the 10 shocks in each axis in half-sine wave, 30 g amplitude and of 15 ms duration.

8.2.2 *Requirements*

After the test, no cracks shall be visible on the traction motor and the motor shall be functional when tested at rated voltage and current.

8.3 Damp Heat Test

The object of this test is to determine the suitability of the traction motor for use and storage under conditions of high relative humidity when combined with cyclic temperature changes.The number of conditioning cycles shall be 21 and upper temperature shall be 40 °C. The test shall be carried out as per IS 9000 (Part 5)/ Sec 1).

8.3.1 *Requirements*

After the test the traction motor shall show no cracks and damage and the motor shall be functional when tested at rated voltage and current.

8.4 Media Resistance Test with Motor Vehicle Fuels

The test shall be carried out as follows:

8.4.1 *Test Method*

In a test cycle, the traction motor is soaked with test fluid and stored under enhanced ambient temperature.

8.4.2 *Test Equipment*

Following equipment is generally required based on the need. Any of the two can be used to wet the motor:
a) Scooping container for dipping,
b) Spray gun,
c) Brush,
d) Forced exhaust for exhausting vapours dangerous to health, and
e) Explosion proof thermal cabinet.

8.4.3 *Test Conditions*

The motor shall be tested with all the fluids to which it is exposed, from the following list of test fluids as agreed between the motor and vehicle manufacturers:
a) Window screen cleaner,
b) Cooling fluid,
c) Cold cleaning medium (commercially available),
d) Gearbox oil (manual gear box),
e) ATF-Oil (automatic and steering aid),
f) Rear axle oil,
g) Protective grease,
h) Wax remover,
j) Brake fluid, and
k) Battery acid.

8.4.4 *Test Cycles*

The test is carried out in cycles, where duration of one test cycle is 24 h. During the test cycle, the traction motor is handled as follows:
a) wet for 5 s with test fluid; and
b) store for 24 h in thermal cabinet at 80 °C.

The above procedure should be repeated for each of the test fluids mentioned above. Number of test cycles as agreed.

8.4.5 *Requirements*

After the test, including a generation phase to be agreed, there shall be no deformation, discoloration or formation of crack and the motor shall be functional when tested at rated voltage and current.

8.5 Salt Spray Test

The test shall be carried out as per IS 9000 -11.

8.5.1 *Requirements*

After the test the traction motor shall show no damage and shall be functional when tested at rated voltage and current.

8.6 Thermal Shock Test

8.6.1 *Purpose*

The purpose of this test is to verify the resistance of the traction motor to sudden changes in temperature. The motor shall undergo a specified number of temperature cycles, which start at ambient temperature followed by high and low temperature cycling. It simulates a rapid environmental temperature change which a traction motor would experience during its life.

8.6.2 *Installations*

This test shall be conducted with the complete motor and its electrical connections but without power supply.

8.6.3 *Test Procedure*

The tested-device shall be stored for at least 6 h at a test temperature equal to 60 ± 2 °C or higher if requested by the manufacturer, followed by storage for at least 6 h at a test temperature equal to -40 ± 2 °C or lower if requested by the manufacturer. The maximum time interval between test temperature extremes shall be 30 mintue. This procedure shall be repeated until a minimum of 5 total cycles are completed, after which the tested-device shall be stored for 24 h at an ambient temperature of 20 ± 10 °C.

8.6.4 *Requirements*

After the test the traction motor shall show no damage and shall be functional when tested at rated voltage and current.

8.7 Electromagnetic Interference/Compatibility Test

This test shall be carried out along with the electronic controller to be used along with the electric traction motor. The motor and controller

shall comply with the requirements of AIS 004 (Part 3).
Alternatively, Vehicle level compliance as per AIS 004 (Part3) as notified time to time shall be deemed to comply with this requirement.

9 MARKING

9.1 The motor shall have the following information marked indelibly and legibly on it:

a) Name and/or trade-mark of the manufacturer;
b) Month and year of manufacture;
c) Country of manufacture;
d) Rated Voltage (V); and
e) Type - AC or DC.

The marking can also be placed near the motor at an easily accessible location.

9.2 BIS Certification Marking

9.2.1 The product may also be marked with the Standard Mark.

9.2.2 The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the BIS Act, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the standard mark.

ANNEX A
(*Foreword*)
COMMITTEE COMPOSITION

Electric and Hybrid vehicles Sectional Committee, TED 27

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